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Power Quality Enhancement Using Power Factor Correction Circuits In Electrical System

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***Abstract* - Power factor adjustment is critical in the power system since it affects all of the loads. The low power factor is responsible for a slew of negative consequences. Consequently, the performance of all loads is compromised. As a result of having the motors coupled, the winding will be impacted. As a result, there are several negative consequences in the electricity system. As a result, it is necessary to enhance the power factor in every way possible. It is extremely important to have a high-power factor in your system. There is a plethora of approaches that may be used to increase power factors. There are devices that create reactive power at the leading and trailing ends of the spectrum. The reactive power produced by an inductor is trailing, while the reactive power produced by a capacitor is leading. Improved power factor is achieved by the usage of the power factor correction circuit in this study. Various capacitor-based circuits are used in this application.**

Index Terms: **reactive power compensation, power factor, capacitor**

I.INTRODUCTION

In a range of applications, including variable speed drives, uninterruptible power supply (UPS), and switching mode power systems, ac-dc converters are employed (SMPS). Power Electronic equipment that is connected to alternating current utility mains use diode rectifiers at the input to ensure proper operation. This is due to the nonlinear nature of the diode rectifier, which causes substantial harmonics to be introduced into the line current, resulting in a reduction in power quality and an increase in losses in the connected devices.

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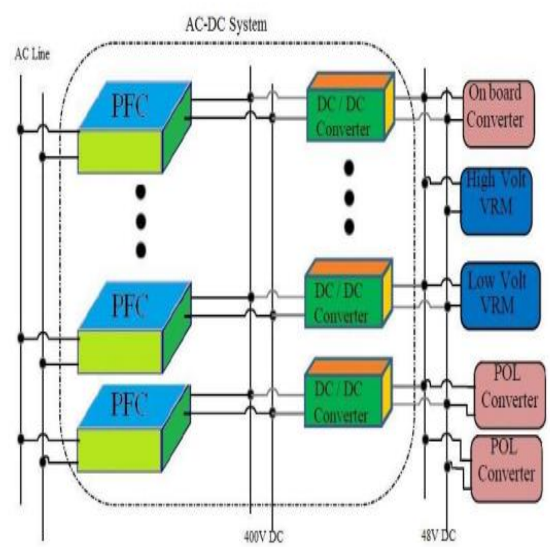

Figure 1. AC/DC power conversion.

It is as a consequence of this those strong international standards have been established and put into effect. A consequence of this is that circuits for reducing harmonics have been included into the PE system. Previously, inductors and capacitors, which were both costly and large, were employed for this purpose because they were effective at eliminating harmonics from the signal.

Consequently, components should be simulated with the lowest feasible operating frequency to guarantee correct performance of soft switched resonant converters, which operate in the mode of variable frequency operation. Increased power is achieved by

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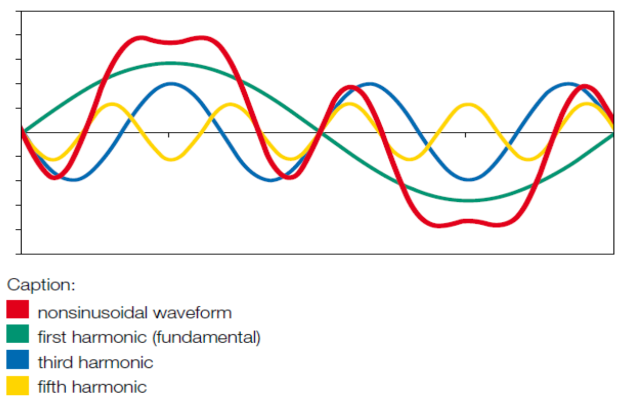
the employment of the boost converter design in continuous conduction mode (CCM) in medium-power alternating current/direct current converters. because it ensures that the power factor on the input side of alternating current terminals is as near to unity as feasible.

A. *Effects of nonlinear load:*

Following are the effects of nonlinear load on power system equipment.

- Heating loss in machines, especially large motors and transformer.
- Over current in neutral wire.
- More consumption of energy.
- Overshoot due to resonance.
- Errors in metering
- Noise from the machines.



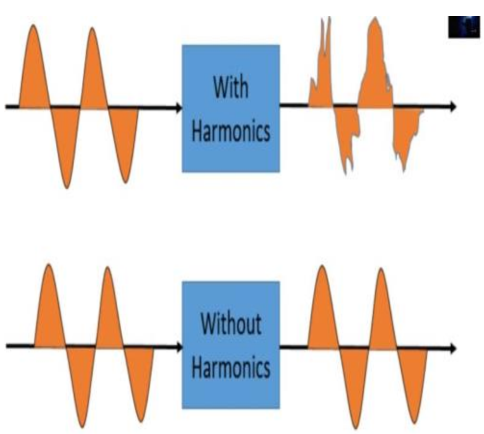


Figure 2. System effects by harmonics.

II POWER FACTOR CORRECTION

A. *Passive power factor correction:*

Passive devices such as an inductor or a capacitor are used in this procedure. Whenever the leading effect is necessary for control, the lagging effect is injected to provide that control. The capacitor is used in order to control the lagging effects.

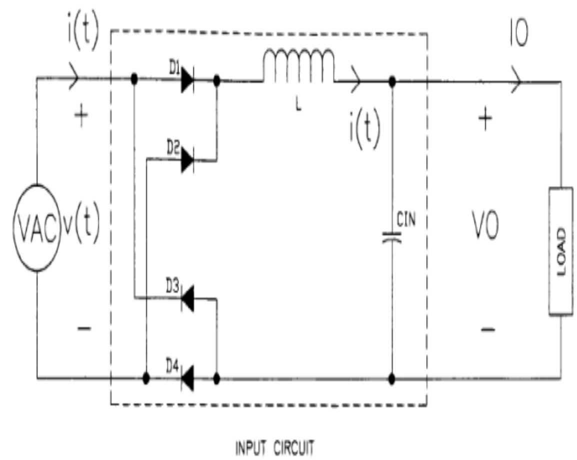


Figure 3. Inductive Filter.

B. *Resonant filter:*

This type of filter works based on the resonance phenomenon.

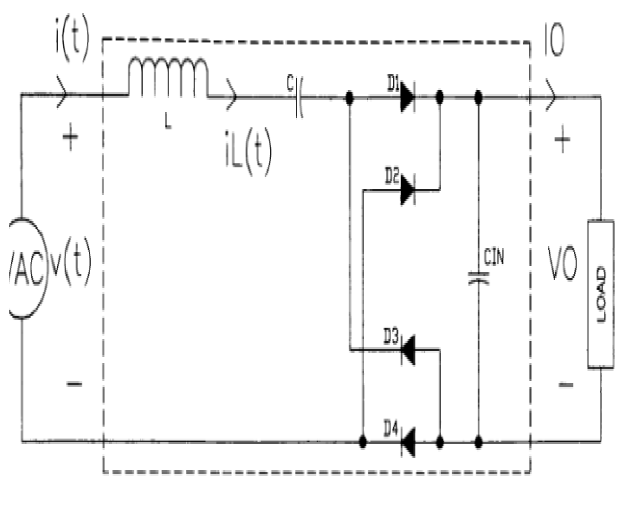


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Figure 4. Rectifier using resonant filter.

C. Active power factor correction methods:

The active PF correction methods utilize active elements and controlled switches for power factor correction. Power factor correction is of two types.

- ➢ Making lagging to unity power factor
- ➢ Adjusting leading PF to unity power factor.

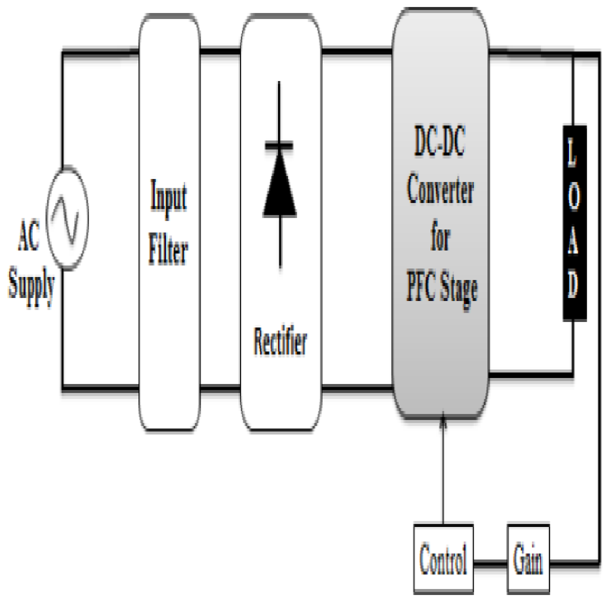

Figure 5. Active PF correction Block diagram.

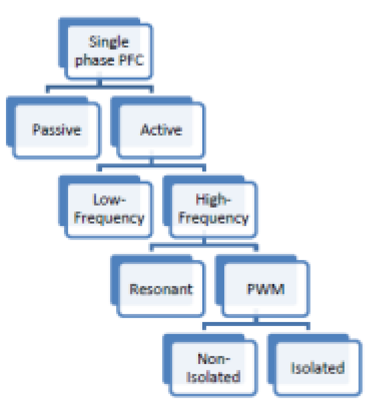

Figure 6. Classification of PF Correction circuits.

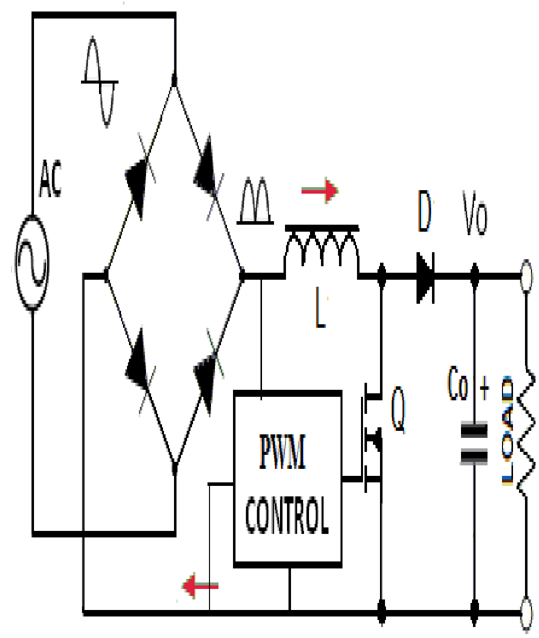

Figure 7. PF correction using PWM control.

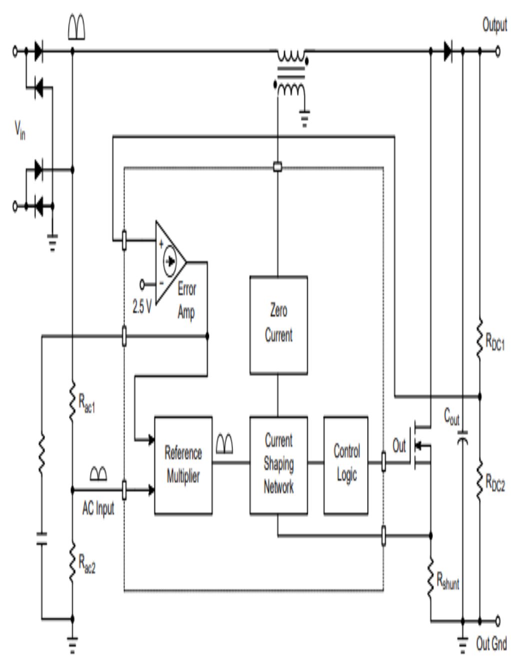

Figure 8. Active PF circuit.

It has recently been proposed to use single-stage PFC converters, which merge the PFC stage with the DC/DC stage into a single stage, to reduce

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the cost of the converter by as much as 50%. The main notion is that the PFC stage and the DC/DC stage share a common switch, allowing for the reduction of the number of primary switches and their associated controllers by one.

However, the control flexibility has been severely curtailed, and only one control variable may now be controlled at any one time. The output voltage of most applications, in contrast to the power factor, must be accurately regulated, while the power factor cannot be exactly controlled. Consequently, it is required for the PFC stage to incorporate a power factor adjustment feature integrated into it.

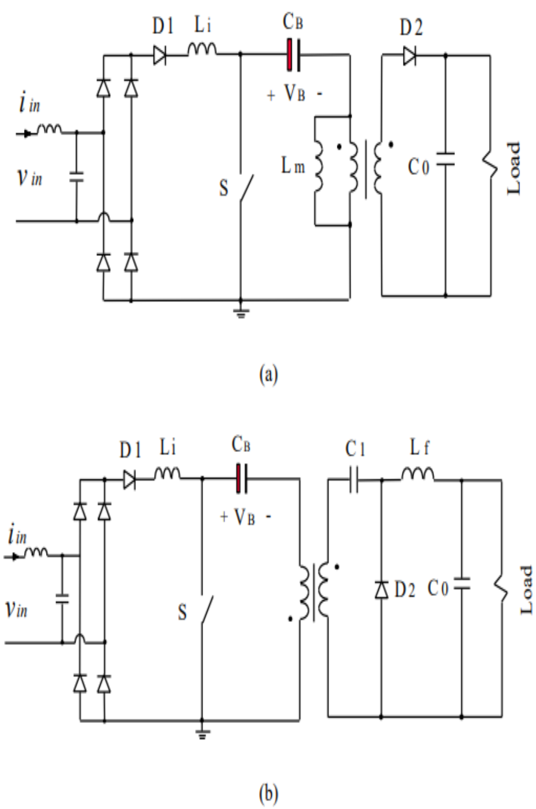


Figure 9. Magnetic couple PF correction.

Both the PFC stage and the DC/AC converter share a similar power switch, which allows them to work together seamlessly. This means that both the boost switch and the controller may be spared, which results in an overall decrease in the total cost of ownership. Figure is an example of an integrated PFC electronic ballast with a power factor correction. In contrast, in order to work effectively, the shared switch must take current not just from the power factor correction stage, but also from the resonant tank.

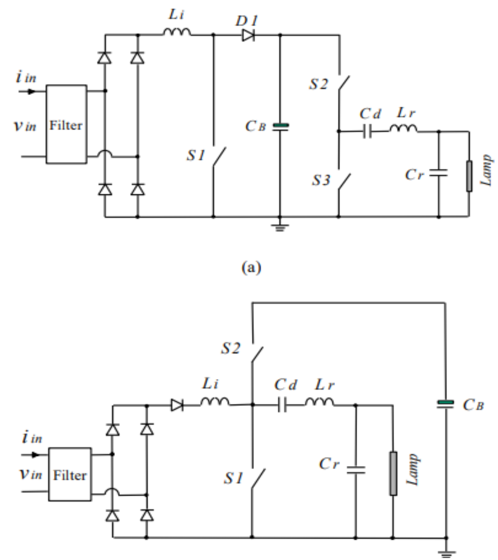


Figure 10. Two stage PF correction.

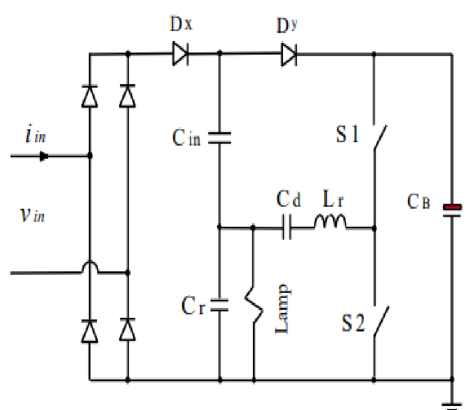


Figure 11. Capacitor based circuit.

III SIMULATION RESULTS

Neither the integrated single-stage power factor correction converters nor the previously proposed CPPFC converters have a continuous input current since they are discontinuous in nature. A large EMI filter is necessary in order to do this. The integrated single-stage PFC converters and the VS-CPPFC converters suffer from high current stresses in the power switches as a result of the fact that they carry current not only from the reflected load but also from the PFC stage. These people are now suffering stress levels that are about twice as high as those seen in the two-stage technique. - Because they entail the use of devices with high current ratings, which are costly, they are unattractive for manufacturers.

The CS-CPPFC electronic ballast is not recommended for use due to the relatively high voltage stress it is subjected to during operation. It is possible to achieve low total harmonic distortion (THD) and crest factor even without using feedback control using the VSCS-CPPFC electronic ballast.

When connected to a 200V line, the device also has a low switching current stress and an acceptable DC bus voltage stress, indicating that it is well-suited for this application. Due to the fact that the DC bus voltage will be too high at start-up for 265 V line input, it is not suitable for line input applications with a wide range of voltages. For a wide variety of line input applications, steady lamp power, a low crest factor, and total harmonic distortion (THD) are all important considerations to take into consideration.

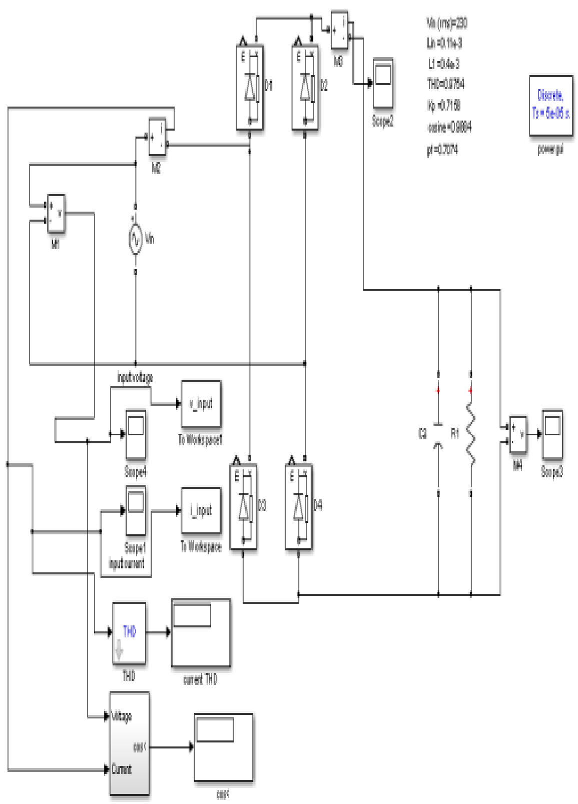


Figure 12. Main Simulation circuit.

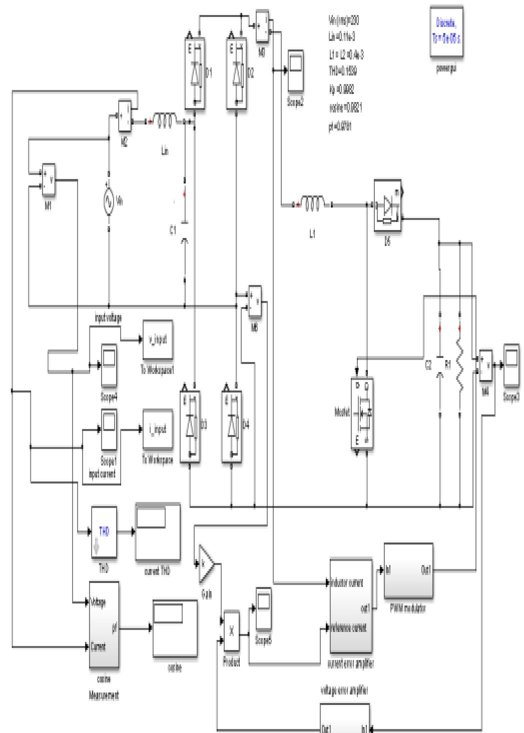
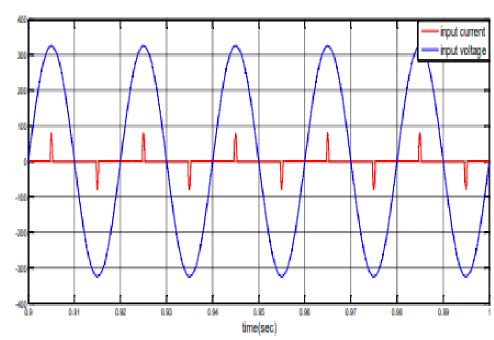
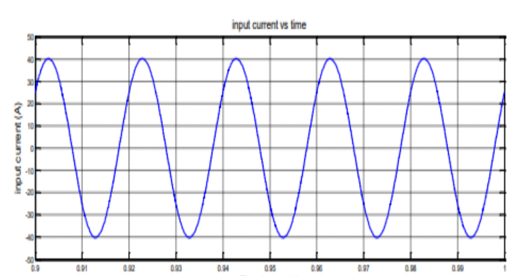


Figure 13. Control circuit in MATLAB.





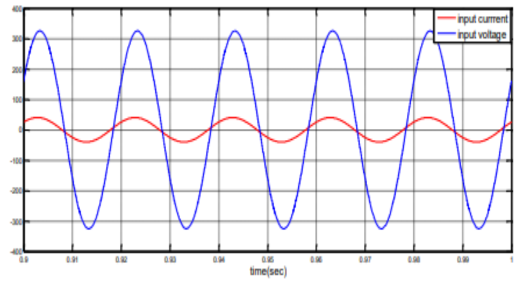
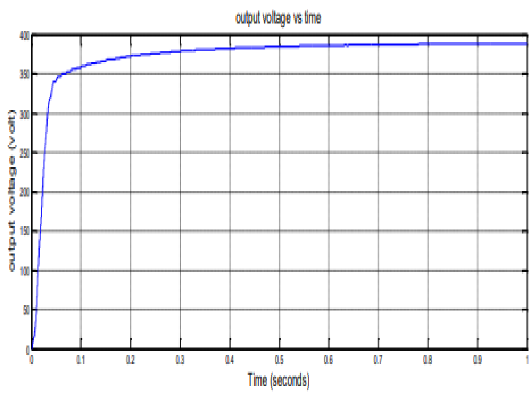


Figure 14. Output voltages



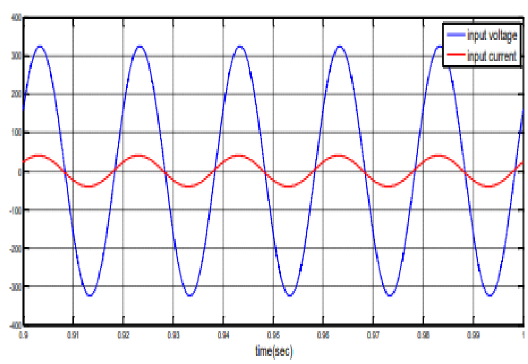


Figure 15. Input voltage and input current.

CONCLUSION

Following conclusions are made from the work carried out in this project.

- Design of a buck PF converter.
- Design of Boost PF converter
- Simulation of Buck Boost PF converter.

FUTURE SCOPE

Following aspects of the work are left as the future scope of this project.

- Control of PF circuit using PWM methods
- Automatic PF circuit design.
- Online control of power factor.

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